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Dated 17 December 1999

Form 1/77

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Request for grant of a patent

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1.	Your reference	DH/AH/G5596
2.	Patent application number *(The Patent Office will fill in this part)*	15 APR 1999 **9908504.5**
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	PJO (INDITHERM) LTD COMMERCIAL ROAD GOLDTHORPE ROTHERHAM S63 9BL
	Patents ADP number *(if you know it)*	
	If the applicant is a corporate body, give the country/state of its incorporation	GB
4.	Tile of the invention	CONDUCTIVE MATERIALS
5.	Name of your agent *(if you have one)*	*Hulse & Co*
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	*St James House,* *8th Floor* *Vicar Lane* *Sheffield S1 2EX*
	Patents ADP number *(if you know it)*	885002

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Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*

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Continuation sheets of this form	
Description	6
Claim(s)	-
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Priority documents	
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Statement of Inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of patent on the basis of this application.

Signature

Date

14 April 1999

AS AGENTS FOR THE APPLICANT

12. Name and daytime telephone number of person to contact in the United Kingdom

D HOUGHTON

(0114) 276 9381

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Notes

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CONDUCTIVE MATERIALS

This invention relates to conductive materials and is particularly concerned with conductive materials to serve the purpose of a heating means.

It has long been known that materials that are electrically conductive can generate heat. This phenomenon has spawned a considerable number of heating means for a considerable number of different purposes.

Whilst electrical heaters at large are generally successful, and more than capable of meeting their intended purpose, what has proved to be difficult, is the achieving of a uniform heating effect over a relatively wide area, substantially free from hot and cold spots or areas.

There have been attempts hitherto to create electrical heaters in sheet or web form to serve a wide variety of purposes. However, the most usable form of conductive material is in the form of carbon particles or carbon black embedded in or coated on a carrier or substrate. To attempt to achieve a uniform heating effect, a greater density or concentration of carbon particles is employed, but as a direct result of that, the material becomes less pliable and more brittle, to the detriment of the employment of the material over a wide range of potential uses.

The first object of the present invention is to provide a start or batch material able to be used in a variety of different physical forms to suit a wide variety of electrical conduction heaters.

Second and subsequent objects of the invention are to transform the start or batch material into products that are electrical conductive heaters for a wide variety of different purposes.

According to a first aspect of the invention a method of forming a compound for an electrically conductive heater comprises stirring fine carbon particles into a polymer base containing an anti-absorption compound, to achieve carbon particles to polymer levels of 43% by weight to 73% by weight, and subjecting mixture to high speed stirring for a pre-determined period of time, with the maintenance of the mixture at not more than 25°C, to grind the carbon

particles to a predetermined final fineness.

Preferably the required carbon particle to polymer level is 53%.

The resultant mixture exhibits thixotropic rheological properties, and if required, the viscosity of the mixture can be reduced, by the addition of a suitable solvent such as dimethylformamide an aliphatic polyurethane solution.

Preferably the carbon black particles have particulate size of approximately 30 En nm and the solvent carrier is dimethylformamide. Suitable adsorbants may be polypropylene glycol, polyethylene glycol, diethylene glycol etc. After this process is complete a suitable polymer solution eg an aliphatic polyurethane is added to the master batch such that the ratio of polymer to carbon black is 1:0.57 on a dry basis. The finished compound is then refiltered prior to any coating process.

The duration of the slow stirring-in of carbon black is not critical, but desirably high speed stirring is limited to not more than 30 minutes.

Once the mixture is prepared, it is checked by taking a sample and passing it through a 300 mesh filter, preferably with the aid of a low pressure displacement pump, or by using a Heckman gauge, to ensure that there has been no agglomeration of the carbon particles during mixing. If any agglomeration is detected, the mixture should be subjected to further high speed stirring.

Preferably, the prepared start or batch material is subjected to a final filtration step by passing the mixture through a 200 mesh filter cloth, for example by way of a slow, low pressure positive displacement pump, at which stage there should be no residue left on the filter cloth that would signal that there was still a degree of remnant agglomeration of carbon particles.

In the form where the start or batch material employs dimethyloformamide and polyethylene or propylene glycol as the polymer base and adsorption agent, it constitutes an ideal

material to serve as a coating or a base or carrier material.

According to a second aspect of the invention a web or sheet is formed by applying a quantity of finished compound as discussed above to a release paper by way of transfer coating, to achieve a uniform coating or film of compound between 90 and 100 grams per square meter, and subjecting the web or sheet to heat progressively rising from 110°C to 150°C to achieve the controlled release of solvents and provide a coating or film free of pinholes.

As the electrical conductivity, and hence the heating effect achievable is a function of coating or film thickness the above process is repeated until a desired thickness of coating or film is created.

At this stage considerable care must be exercised to ensure that reticulation is avoided, and as it is preferred to spread the finished compound on the release paper by employing a doctor blade, equally considerable care exercised to ensure the avoidance of the presence of dirt or grit on the blade edge, to prevent the creation and spread of lines of indentations in the coating or film.

Desirably, the release paper is matt grade and is an unembossed silicone-coated paper.

According to a still further aspect of the invention, a flexible fabric able to serve the purpose of an electrical conductive heater is formed by taking the release paper mentioned above with its coating of finished compound spreading thereon a further quantity of said compound, laying the release paper on a flexible fabric carrier sheet or web, and passing the composite through a fixed gap roller to ensure controlled penetration of said compound into the fabric of the sheet or web, the sheet or web thereafter being subjected to heat progressively rising from 110°C to 150°C to achieve controlled release of solvents and provide a coating of film free of pinholes.

Such a sheet or web can be of any desired length, and of any width with the limits of

available fixed gap rolls.

By the nature of the coat or film, there is a substantially totally even spread of carbon black at loadings in the polymer material considerably beyond what has hitherto been believed to be possible whilst at the same time leaving the fabric with its film or coat totally flexible.

The fabric may be a knitted cotton material but can be of any other suitable form, such as a weft knitted polyvinyl alcoholic fabric.

The preparation of the said compound and the manner of its application to a release paper and then a fabric carrier is such that a visually smooth coating or film is provided. However, it remains so that the coating will exhibit a microscopic degree of roughness with peaks and troughs formed by carbon particles at the exposed surface. It is then important to pay special attention to the provision of an electrical connection to the coat or film.

According to yet another aspect of the invention an electrical connection to a coat or film incorporating carbon particles is formed by first spraying a nickel compound to an area of the coat or film, and applying to the sprayed area a tin-copper tape coated with a silver loaded conductive adhesive. With the electrical connection installed, the sheet or web can be connected to a suitable power source with the substantial guarantee that there will be no shorting or arcing at the point of electrical connection, and consequently no damage by the creating of hot spots.

Dependant on the use to which the sheet or web is put, an electrical connection can be provided over long lengths to opposite edges, to assist in the even input of power to the coat or film over a wide area.

An important aspect of the invention is that the totally uniform heating effect achievable in the coat or film can be with relatively low power, eg 24 volts, and by controlling the width between the electrodes, and the thickness of the coat or film, a constant temperature can be achieved and maintained, at any required level to serve a particular purpose.

In its form as a flexible sheet or web, the invention has a considerable number of available uses. It can be wrapped round an article the temperature of which is to be maintained and equally can be incorporated into clothing for use in extremely cold climates, to maintain the temperature of the wearer.

However, the fabric has significant benefits when used in medical contexts. It can be incorporated in a mattress or as a blanket for the recovery ward for maintaining the temperature of extremely ill patients, and equally can be incorporated into the surfaces of operating tables or overlays for operating tables to ensure the maintenance of body temperature of patients during surgery.

It is possible to employ the fabric into sleeping or carrying bags for use by rescue services to give immediate aid to accident victims suffering from hyperthermia.

In all such uses, the low voltage required means that there is total safety to the user. The voltage and coat or film thickness can determine the maximum and constant temperature across the full width and length of the fabric at average body temperature.

In addition to being able to control maximum temperatures by voltage control and by control of the spacing between electrodes, it is a highly advantageous feature of the invention that the predetermined maximum temperature is achieved in the same time, approximately 30 minutes from the onset of power, after which the temperature is self regulated at its predetermined level. This can be of considerable importance in such as the food industry and particularly in food processing where a required temperature must be achieved quickly and maintained.

In addition to its use in conjunction with a flexible fabric, the said compound can be used differently. For example, it may be sprayed onto products whereby to provide heat uniformly over the whole surface of a complex product. The said compound can be screen printed onto support surfaces, or can be directly coated on to a product surface. Equally it can be calendered

or hot melt coated from dry compound to produce flexible sheets, or can be applied by a powder coating technique to produce heatable laminates.

A further possibility within the invention is to provide a said compound where the polymer material into which the carbon black is stirred is such as to make the compound suitable for moulding or casting. Thus, form- stable sheets or shapes of material can be produced that can be used in a number of industrial applications, such as sub floor heater pads, sub soil heater pads, linings for fly ash hoppers in power stations the temperature of which needs to remain constant to avoid the ash from becoming damp, or shapes for location in for example aircraft wings to ensure that the wings do not ice up, or placement around such as pump and valve castings, to prevent them from freezing and hence malfunctioning. In addition the said compound can be moulded around vessels for warming chemical or medical liquids.